

The *Drosophila virilis* Section (Diptera: Drosophilidae) from Guangdong Province, Southern China

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ABSTRACT—Four new and nine known species of the *Drosophila virilis* Section are reported from Guangdong Province, southern China, with special reference to the Old World *virilis-repleta* Radiation. *Drosophila virilis*, a well-known cosmopolitan domestic species, was collected at natural environments of Heishiding, suggesting that China is the original range of distribution. The *wakahamai* species-group is newly established by two known and two new species, and its taxonomic relationship is discussed.

INTRODUCTION

The recent faunal surveys on drosophilid flies have demonstrated that southern China is an important area for the study of the *virilis-repleta* Radiation in the genus *Drosophila* [1-4]. The present paper deals with four new and nine known species of the *virilis* Section from Guangdong Province and with the establishment of one new species-group, the *wakahamai* species-group.

Most of the specimens were collected at watersides in the Babaoshan Natural Reserve Forest (about 1000 m above sea level), by using traps baited with fermenting bananas. All the holotypes and a part of paratypes are deposited in Guangdong Institute of Entomology, Guangzhou, China, and the remaining paratypes in Biological laboratory, Hokkaido University of Education, Sapporo, Japan.

1. *Drosophila wakahamai* Species-group

Diagnosis. Black and slender species. Arista with *ca.* 3 upper and *ca.* 1 lower long branches in addition to large terminal fork. Second oral minute. Wing entirely blackish or brownish fuscous. C-index *ca.* 3.7 to 4.7 and C3-fringe *ca.* 0.4. Lower

part of epandrium narrowing distally and curved inward. Surstylus black, concaved distally. Cercus fused to epandrium. Aedeagus nearly straight, bilobed; but lateral lobes fused apically. Anterior paramere pubescent. Posterior paramere absent. Novasternum without submedian spines. Lobe of ovipositor slender, apically pointed.

In addition, this group flies prefer riparian environments with high humidity and utilize fallen trees for feeding substrates.

This newly established species-group consists of *D. wakahamai* Toda et Peng, 1989 from southern China [1], *D. fusus* Okada, 1988 from Sri Lanka [5] and the following two new species.

Relationships. Table 1 shows eleven characters of ecology (I-II), external morphology (III-VI) and genitalia (VII-XI) in the *wakahamai* and other species-groups of the *virilis* Section including one ungrouped species, *D. fluvialis* Toda et Peng, 1989 from Guangdong Province [1]. These characters are:

- I. Habitats: watersides (W) or forests (F).
- II. Feeding substrates: tree barks (T) or unknown (?).
- III. Palpus slender (S) with a few prominent bristles at tip or club-shaped (C) without such bristles there.
- IV. Number of pairs of dorsocentrals: 2, 3, or 4 pairs.
- V. Costal index: larger (L) or smaller (S) than

TABLE 1. Comparison of ecology, external morphology and genitalia among six species-groups and one ungrouped species of the *Drosophila virilis* Section

Species-group	Ecology		External Morphology				Genitalia				
	I ¹⁾	II	III	IV	V	VI	VII	VIII	IX	X	XI
<i>polychaeta</i> group	W	?	C	3	S	L	S:F ²⁾	C	B	B	O
<i>quadrisetata</i> group	W	?	C	4	L	L	S(F) ³⁾	C	B	B	O
<i>robusta</i> group	W(F)	T	C	2	L(S)	L(S)	F	C	B	B:P	W:O
<i>virilis</i> group	W	T	S	2	L	L	F	C	P	P	W
<i>melanica</i> group	F	T	C	2	L	S	F	S	P	P	W
<i>wakahamai</i> group	W	T	S	2	L	S	F	S	P	P	O
<i>D. fluvialis</i>	W	?	C	2	L	L	F	C	B	P	O

¹⁾ The character states and abbreviations are explained in the text.

²⁾ The colons mean that two kinds of the character states are found in nearly the same ratio [1, 3, 4, 6, 15].

³⁾ The parentheses indicate that a few exceptional species are involved in the respective species-groups [1, 3, 6].

3.0.

- VI. C3-fringe ratio: larger (L) or smaller (S) than 3/5.
- VII. Cercus fused to (F) or separated from (S) epandrium.
- VIII. Aedeagus nearly straight (S) or ventrally curved (C).
- IX. Anterior paramere bare (B) or pubescent (P).
- X. Novasternum bare (B) or pubescent (P).
- XI. Novasternum with (W) or without (O) submedian spines.

The number of matching characters between the *wakahamai* and the *melanica* species-groups is very high, and the matchings are seen in eight items (II, IV-X). In particular, the *wakahamai* species-group characteristically has a straight aedeagus (VIII) common only to the *melanica* group. A relatively small value of C3-fringe ratio is exclusively found in both the *wakahamai* and the *melanica* species-groups, with a few exceptional cases in the *robusta* group.

On the other hand, the same number of matchings is seen between the *wakahamai* and the *virilis* species-groups (I-V, VII, IX, X). The general appearance of the *wakahamai* species-group is very similar to that of the *virilis* group in having a slender and black body in addition to a slender palpus (III).

The characters shown in Table 1 suggest that the *wakahamai* species-group might be closer to the *melanica* and/or the *virilis* groups than other

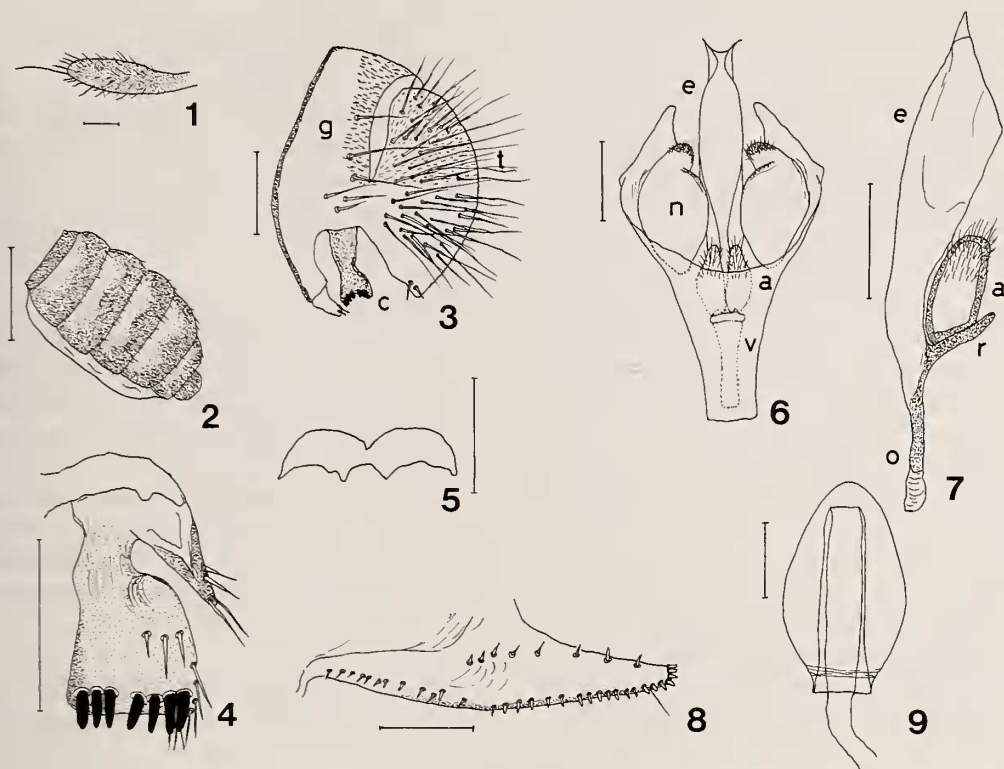
groups of the *virilis* Section, although the *wakahamai* group is very different from the *melanica* and the *virilis* groups in having novasternum without submedian spines (XI).

Drosophila (Drosophila) velox sp. nov.
(Figs. 1-9)

Diagnosis. Abdominal tergites brownish yellow with black caudal bands (Fig. 2). C-index *ca.* 4.75. Epandrium bare except for caudodorsal portion; lower half of cercus bare (Fig. 3).

♂, ♀. Body length *ca.* 3.44 mm (range: 3.20-3.68), thorax length (including scutellum) *ca.* 1.06 mm (0.92-1.20), and wing length *ca.* 3.54 mm (3.32-3.76).

Head: Eye dark red with thick piles. Second joint of antenna reddish brown with 2 stout bristles; 3rd grayish brown. Arista with *ca.* 3 (3-4) upper and *ca.* 1 (1-2) lower branches. Frons dark brown, paler in middle, *ca.* 0.48 (0.46-0.51) as broad as head, anteriorly with a few frontal hairs. Anterior reclinate orbital (Orb 2) *ca.* 0.25 (0.17-0.33) length of posterior reclinate orbital (Orb 1); proclinate orbital (Orb 3) *ca.* 0.67 (0.50-0.83) length of Orb 1. Face dark brown; carina high, wider below. Clypeus blackish brown, slightly narrowing in middle. Cheek dark brown, *ca.* 0.21 (0.18-0.24) as broad as a maximum diameter of eye, with several bristles along lower margin. Second oral (Or 2) minute. Palpus blackish brown, with 1 prominent long bristle at tip (Fig.



FIGS. 1-9. *Drosophila (Drosophila) velox* sp. nov. 1: Palpus. 2: Abdominal tergites. 3: Periphallallic organs. 4: Surstylus. 5: Decasternum. 6: Phallic organs. 7: Aedeagus (lateral view). 8: Ovipositor. 9: Spermatheca. Signs: a, anterior paramere; c, surstylus; e, aedeagus; g, epandrium; n, novasternum; o, aedeagal apodeme; r, vertical rod; t, cercus; v, ventral fragma. Scale-line=0.1 mm except for Fig. 2 (1.0 mm).

1).

Thorax: Mesoscutum black, with 2 obscure dark longitudinal stripes between dorsocentrals. Scutellum blackish brown, anteriorly somewhat paler on lateral side. Lower humeral subequal to upper one. Anterior dorsocentral (DcA) *ca.* 0.85 (0.65-1.00) length of posterior dorsocentral (DcP); length distance of dorsocentrals *ca.* 0.41 (0.36-0.47) of cross distance. Acrostichal hairs (Ac) in 8 irregular rows. Anterior scutellars (SctA) slightly and posteriors (SctP) strongly convergent; distance from SctA to SctP subequal to distance between SctPs. Relative length of anterior/posterior sternopleural (Sterno-index) *ca.* 0.70 (0.68-0.71).

Legs blackish brown, paler at joints; preapicals on all three tibiae; apicals on fore and mid tibiae.

Wing fuscous, paler in middle of cells, somewhat

tapering at tip. Veins dark brown; crossveins fuscous. R_{2+3} curved to costa at tip; R_{4+5} and M nearly parallel. C_1 bristles 2. Number of small stout setae on 3rd costal section (C_3) *ca.* 8 (6-10). Wing indices: C *ca.* 4.75 (4.54-4.95), 4V *ca.* 1.63 (1.62-1.65), 4C *ca.* 0.54 (0.49-0.59), 5x *ca.* 1.14 (1.00-1.28), Ac *ca.* 1.15 (1.12-1.18), C_3 -fringe *ca.* 0.36 (0.19-0.53). Haltere yellowish brown, anteriorly darker at base.

Abdomen (Fig. 2): Caudal band on 2nd to 5th tergites broadened at middle and lateral side. Sternites pale brown.

Periphallallic organs (Figs. 3-5): Epandrium black, with *ca.* 6 long bristles medially and *ca.* 4 short ones on ventral projection. Surstylus blackish brown, with *ca.* 7 primary teeth on distal margin, *ca.* 3 bristles on outer surface and several bristles at caudoventral corner. Cercus black, with

ca. 44 bristles. Decasternum dark brown, bat-shaped.

Phallic organs (Figs. 6–7): Aedeagus dark brown, bilobed but fused in upper half, apically pointed in lateral view; aedeagal apodeme brown, ca. 0.48 length of aedeagus. Vertical rod black. Anterior paramere shallot-shaped, with tiny hairs on distal half. Novasternum dark brown, elliptical, with tiny hairs. Ventral fragma triangular.

♀ reproductive organs (Figs. 8–9): Lobe of ovipositor orange, darker on distal margin, with ca. 8 discal and ca. 30 marginal teeth. Spermatheca light brown, slightly wrinkled basally; introvert deep, ca. 0.88 height of outer capsule.

Holotype ♂, China: Babaoshan, Guangdong Province, 12. XI. 1989 (ex. trap, collector: H. Watabe).

Paratype 1 ♀, same data as holotype except 11. XI. 1989.

Distribution. China: Guangdong Province.

Relationships. This species is easily distinguishable from the other three species of this group by the abdominal tergites with black caudal bands.

Drosophila (Drosophila) hei sp. nov.
(Figs. 10–17)

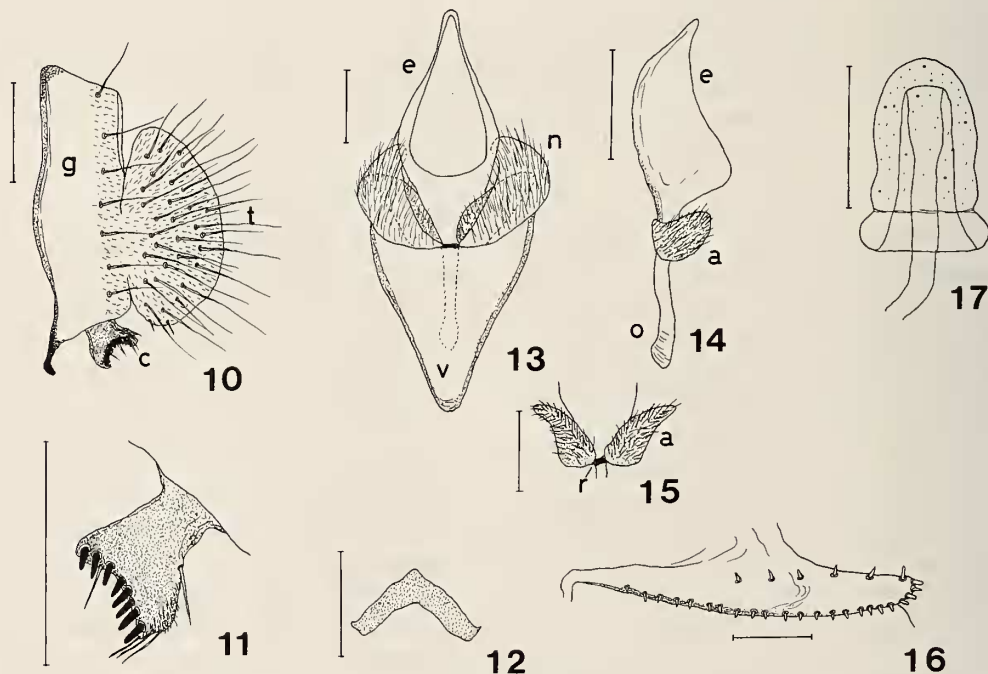
Diagnosis. Abdominal tergites entirely black. Epandrium pubescent on caudal half, posteriorly with ca. 7 long bristles (Fig. 10). Novasternum dark brown, with numerous hairs (Fig. 13). Spermatheca constricted at 1/5 portion from base (Fig. 17).

Some characters (eyes, frons, clypeus, Or 2, legs, etc.) are the same as in the foregoing species, and not referred to in the following description.

♂, ♀. Body length ca. 3.55 mm (3.20–3.64), thorax length ca. 1.42 mm (1.28–1.56), and wing length ca. 3.69 mm (3.40–4.08).

Head: Arista with ca. 3 (2–3) upper and 1 lower branches. Frons black, ca. 0.51 (0.47–0.54) as broad as head. Orb 2 ca. 0.27 (0.19–0.36) length of Orb 1; Orb 3 ca. 0.61 (0.44–0.75) length of Orb 1. Cheek ca. 0.30 (0.19–0.41) as broad as maximum diameter of eye.

Thorax: Mesoscutum with 2 longitudinal black bands between dorsocentrals. Lower humeral ca.



FIGS. 10–17. *Drosophila (Drosophila) hei* sp. nov. 10: Periphallic organs. 11: Surstylus. 12: Decasternum. 13: Phallic organs. 14: Aedeagus (lateral view). 15: Anterior paramere. 16: Ovipositor. 17: Spermatheca. Scale = 0.1 mm. Signs as in Figs. 1–9.

0.59 (0.46–0.73) length of upper one. Ac in 6 regular rows. DcA ca. 0.71 length of DcP; length distance of dorsocentrals ca. 0.52 (0.41–0.59) cross distance. Sterno-index ca. 0.75 (0.50–0.91).

Wing blackish fuscous. Veins dark brown; crossveins clear. Number of C3 ca. 12 (10–14). Wing indices: C ca. 3.68 (3.24–3.96), 4V ♂ ca. 1.57 (1.52–1.67) and ♀ ca. 1.49 (1.46–1.50), 4C ca. 0.61 (0.46–0.65), 5x ca. 1.07 (0.90–1.25), Ac ca. 1.89 (1.67–2.08), C3-fringe ♂ ca. 0.31 (0.28–0.33) and ♀ ca. 0.41 (0.36–0.50).

Periphallalic organs (Figs. 10–12): Surstylus black, pubescent at lower margin, distally with ca. 8 primary teeth and ca. 4 bristles at distal margin, and medially with 1 prominent stout bristle. Decasternum black, V-shaped in ventral view. Cercus with ca. 32 bristles.

Phallic organs (Figs. 13–15): Aedeagus brown, laterally swollen submedially; apodeme as long as aedeagus. Anterior paramere dark brown, with tiny hairs on outer surface. Vertical rod rudiment. Ventral fragma brown, triangular.

♀ reproductive organs (Figs. 16–18): Lobe of ovipositor with ca. 6 discal and ca. 22 marginal teeth. Spermatheca brownish yellow, with spinules on outer surface; introvert deep, ca. 0.86 height of outer capsule.

Holotype ♂, China: Babaoshan, Guangdong Province, 13. XI. 1989, (ex. trap, H. Watabe).

Paratypes: 1 ♂, 4 ♀, same data as holotype, except 2 ♀ (11. XI. 1989, from cliff shelters, M. J. Toda).

Distribution. China: Guangdong Province.

Relationships. This species is very similar to *D. wakahamai* in the general appearance and wing indices, but clearly distinguishable from the latter by the diagnostic characters. In addition, the collection records of *D. hei* in Guangdong Province are shifted to higher elevations (ca. 1000 m above sea level) than those of *D. wakahamai* (ca. 300 m).

2. *Drosophila quadrisetata* Species-group

Drosophila (Drosophila) barutani Watabe et Liang, in Watabe, Liang et Zhang, 1990 [4]

Specimens examined: China: 4 ♂, 1 ♀, 30. X. 1989 (K. Beppu); 5 ♂, 9 ♀, 11–13. XI. 1989 (H.

Watabe), Babaoshan, Guangdong Province.

Distribution. China: Yunnan Province, Guangdong Province (new loc.).

Drosophila (Drosophila) pilosa sp. nov. (Figs. 18–22)

Diagnosis. Palpus club-shaped, with 1 short bristle at tip (Fig. 18). C3-fringe ratio ca. 0.69. Cercus fused to epandrium (Fig. 19).

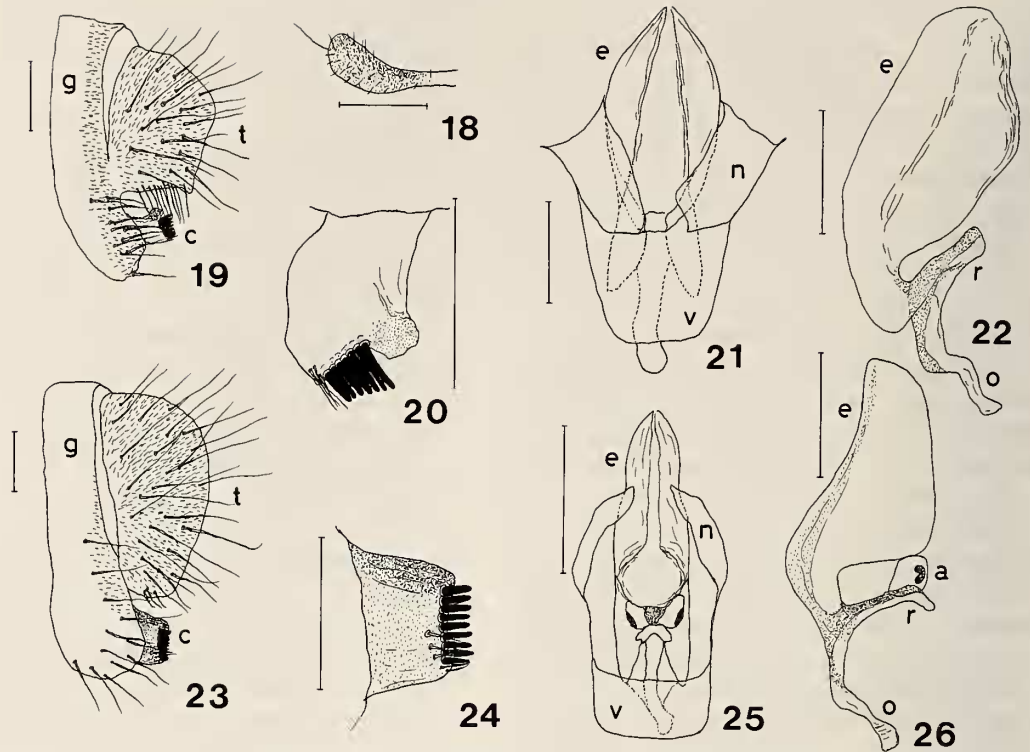
♂. Body length ca. 2.92 mm, thorax length ca. 1.36 mm, and wing length ca. 3.28 mm.

Head: Eye brownish red with thick piles. Second joint of antenna reddish brown; 3rd grayish brown. Arista with ca. 4 upper and ca. 1 lower branches. Frons dark brown, ca. 0.45 as broad as head. Orb 2 ca. 0.33 length of Orb 1; Orb 3 ca. 0.42 length of Orb 1. Face brown; carina high, wider below. Clypeus reddish brown. Cheek brown, ca. 0.39 as broad as maximum diameter of eye. Or 2 ca. 0.23 length of vibrissa (Or 1).

Thorax: Mesoscutum brown, medially with obscure darker longitudinal stripe, broadened behind cross line between 3rd dorsocentrals. Scutellum dark brown. Lower humeral ca. 0.64 length of upper one. Two extra pairs of dorsocentrals present in front of usual ones. Anterior acrostichal bristles present between 1st (anterior-most) dorsocentrals; posterior ones between 2nds. Relative lengths of dorsocentrals and acrostichal bristles to 4th (posterior-most) dorsocentral: 1st dorsocentral ca. 0.50, 2nd ca. 0.54, 3rd ca. 0.69, anterior acrostichal bristle ca. 0.27, posterior one ca. 0.35. Length distance from 1st dorsocentral to 2nd ca. 0.47, distance from 2nd to 3rd ca. 0.47, distance from 3rd to 4th ca. 0.53 cross distance between 3rds. Ac in 6 irregular rows. SctA ca. 0.88 length of SctP; distance from SctA to SctP ca. 1.43 cross distance between SctPs. Sterno-index ca. 0.67.

Legs dark brown; preapicals on all three tibiae; apicals on fore and mid tibiae.

Wing hyaline, slightly fuscous. Veins dark brown; crossveins clear. R_{2+3} straight; R_{4+5} and M parallel. C_1 bristles 2, subequal. Number of C3 ca. 24. Wing indices: C ca. 3.46, 4V ca. 1.83, 4C ca. 0.72, 5x ca. 1.31, Ac ca. 2.17. Haltere white, anteriorly brown at basal part.



FIGS. 18–26. —18–22, *Drosophila (Drosophila) pilosa* sp. nov.; 23–26, *Drosophila (Drosophila) flumenicola* sp. nov. 18: Palpus. 19, 23: Periphallal organs. 20, 24: Surstylus. 21, 25: Phallic organs. 22, 26: Aedeagus (lateral view). Signs and scales as in Figs. 1–9.

Abdomen: Tergites dark brown, anteriorly paler; sternites brown.

Periphallal organs (Figs. 19–20): Epandrium light brown, posteriorly pubescent, with *ca.* 9 bristles on lower portion. Surstylus brown, caudodorsally with dark flap, distally with *ca.* 7 primary teeth and *ca.* 4 bristles. Cercus entirely pubescent, with *ca.* 21 long bristles and with *ca.* 13 tassel-like bristles along lower margin.

Phallic organs (Figs. 21–22): Aedeagus yellow, bilobed, ventrally swollen; apodeme yellowish brown, *ca.* 0.38 length of aedeagus. Vertical rod dark brown. Novasternum pale brown, bare.

Holotype ♂, China: Babaoshan, Guangdong Province, 29. X. 1989 (ex. trap, K. Beppu).

Distribution. China: Guangdong Province.

Relationships. This species is closely related to *D. multidentata* Watabe et Zhang, 1990 in having the cercus fused to epandrium [4], but clearly distinguishable from the latter by C3-fringe and

surstylus. Further, the tassel-like bristles along the ventral margin of cercus are white and stout in *D. multidentata* whereas in *D. pilosa* those are light brown and thin. In the *quadrisetata* species-group, cercus connected to epandrium has been found only in *D. multidentata*, and *D. pilosa* is the second case. This character as well as a large value of C index and the ventrally curved aedeagus indicates phylogenetic relationships between this group and the *okadai* subgroup of the *robusta* species-group [6].

Drosophila (Drosophila) flumenicola sp. nov.
(Figs. 23–26)

Diagnosis. C-index *ca.* 3.1. C3-fringe *ca.* 1.0. Epandrium narrowing in submedian to upper part, caudally pubescent only on submedian portion (Fig. 23). Anterior paramere with dark patch on lateral side (Fig. 26).

Some characters that are the same as in the foregoing species are excluded from the following description.

♂. Body length *ca.* 3.26 mm, thorax length *ca.* 1.52 mm, and wing length *ca.* 3.84 mm.

Head: Arista with *ca.* 4 (3–5) upper and *ca.* 1 (1–2) lower branches. Orb 2 *ca.* 0.38 length of Orb 1; Orb 3 *ca.* 0.47 length of Orb 1. Cheek *ca.* 0.24 as broad as maximum diameter of eye. Or 2 *ca.* 0.40 length of Or 1.

Thorax: Mesoscutum brown, medially with darker longitudinal stripe, laterally with 1 pair of obscure stripes outside dorsocentrals. Lower humeral *ca.* 0.75 length of upper one. Relative lengths of dorsocentrals and acrostichal bristles to 4th dorsocentral: 1st dorsocentral *ca.* 0.50, 2nd *ca.* 0.62, 3rd *ca.* 0.73, anterior acrostichal bristle *ca.* 0.40, posterior one *ca.* 0.59. Length distance from 1st dorsocentral to 2nd *ca.* 0.46, distance from 2nd to 3rd *ca.* 0.50, distance from 3rd to 4th *ca.* 0.56 cross distance between 3rds. Ac in 6 rows. SctA *ca.* 0.97 length of SctP; distance from SctA to SctP *ca.* 1.43 cross distance between SctPs. Sternoindex *ca.* 0.74.

Wing: Number of C3 *ca.* 37. Wing indices: 4V *ca.* 1.77, 4C *ca.* 0.80, 5x *ca.* 1.12, Ac *ca.* 1.92.

Abdomen: Tergites dark brown, slightly paler at anterolateral portions.

Periphallallic organs (Figs. 23–24): Epandrium brown, with *ca.* 12 long bristles on lower half. Surstylus dark brown, distally with *ca.* 9 primary teeth and *ca.* 4 short bristles. Cercus separated from epandrium, entirely pubescent, with *ca.* 27 bristles.

Phallic organs (Figs. 25–26): Aedeagus yellowish brown, bilobed, apically narrowing; apodeme brown, *ca.* 0.51 as long as aedeagus. Anterior paramere oval, nearly transparent.

Holotype ♂, China: Babaoshan, Guangdong Province, 13. XI. 1989 (ex. trap, H. Watabe).

Paratype 1 ♂, same data as holotype except 30. X. 1989 (K. Beppu).

Distribution. China: Guangdong Province.

Relationships. This species resembles *D. potamophila* Toda et Peng, 1989 in the external morphology, but can be distinguished from the latter by the diagnostic characters. In addition, *D. flumenicola* (*ca.* 3.3 mm in body length) is larger

than *D. potamophila* (*ca.* 2.5 mm).

3. *Drosophila polychaeta* Species-group

Drosophila (Drosophila) polychaeta Patterson et Wheeler, 1942.

Specimens examined. China: 1 ♂, Guangzhou, 15. XII. 1989 (net collection on vinegar bottles, L. Xie).

Distribution. Neotropics, Micronesia, Hawaii, North America, Europe; China: Yunnan Province, Guangdong Province (new loc.).

Remarks. This species was collected at a vinegar brewery near the center of Guangzhou City, together with a large number of domestic *D. melanogaster*.

4. *Drosophila robusta* Species-group

Drosophila (Drosophila) cheda Tan, Hsu et Sheng, 1949

Specimens examined. China: 2 ♀, Dinghushan, 18. II. 1987 (T. Peng).

Distribution. Korea, China: Hangzhou, Guangdong Province (new loc.).

Remarks. None of collection records of this species has been found since its description in 1949. *D. cheda* is most closely related to a Japanese member of this group, *D. pseudosordidula* Kaneko, Tokumitsu et Takada, 1964 in having ventrally curved aedeagus, plate-like anterior paramere and heavily constricted spermatheca. Thus, this species belongs to the *sordidula* subgroup of the *robusta* species-group [6].

Drosophila (Drosophila) neokadai Kaneko et Takada, 1966

Specimens examined. China: 2 ♀, Babaoshan, 12–13. XI. 1989 (H. Watabe).

Distribution. Japan, China: Yunnan Province, Guangdong Province (new loc.).

Drosophila (Drosophila) gani Liang et Zhang in Watabe, Liang et Zhang, 1990 [3]

Specimens examined. China: 6 ♂, 3 ♀, Heishiding, 2–6. XI. 1988 (H. Watabe); Babaoshan, 7 ♂, 5 ♀, 11–13. XI. 1989 (H. Watabe); 20 ♂, 7 ♀, Dinghushan, 23–26. XI. 1989 (H. Watabe).

Distribution. Japan, China: Yunnan Province, Guizhou Province, Guangdong Province (new loc.).

Drosophila (Drosophila) yunnanensis Watabe et Liang in Watabe, Liang et Zhang, 1990 [3]

Specimens examined. China: 4♂, 9♀, Babaoshan, 28. X.–13. XI. 1989 (K. Beppu & H. Watabe).

Distribution. China: Yunnan Province, Guangdong Province (new loc.).

Drosophila (Drosophila) medioconstricta Watabe, Zhang et Gan in Watabe, Liang et Zhang, 1990 [3]

Specimens examined. China: 4♂, 3♀, Babaoshan, 28. X.–13. XI. 1989 (K. Beppu & H. Watabe).

Distribution. China: Yunnan Province, Guangdong Province (new loc.).

5. *Drosophila virilis* Species-group

Drosophila (Drosophila) virilis Sturtevant, 1916

Specimens examined. China: 1♀, Heishiding, 25–26. VII. 1986 (T. Peng); 1♂, Heishiding, 3. XI. 1988 (H. Watabe); 4♂, vinegar brewery in Guangzhou, 15. XII. 1989 (L. Xie).

Origin. *D. virilis* is a well-known cosmopolitan domestic species, whose large populations have been restricted to two kinds of artificial environ-

ments, timberyards and breweries [7, 8]. Tan *et al.* [9] stated briefly that *D. virilis* occurs in both domestic and wild habitats in China, but at that time only *D. virilis* was known from the East Asia. All members of this species-group are very similar with each other in the external and genitalial characters, and five species including *D. virilis* are now known to be distributed in the East Asia [10]. Therefore, the original distribution range of *D. virilis* has been uncertain. In the Heishiding Natural Forest remote from human habitations, *D. virilis* inhabits watersides, like other members of this group [10, 11]. This suggests that China is the motherland of *D. virilis*.

Drosophila (Drosophila) kanekoi Watabe et Higuchi, 1979

Specimens examined. China: 2♀, Babaoshan, 30. X. 1989 (K. Beppu), 12. XI. 1989 (H. Watabe).

Distribution. Japan, China (new loc.): Guangdong Province.

Remarks. The *virilis* species-group is divided into two major phylads, the *virilis* and the *montana* phylads. From the chromosomal analysis *D. virilis* is considered to be nearest to the hypothetical ancestor of this group, and *D. kanekoi* has some primitive morphological characters common to the two phylads [10, 12]. The presence of these two species strongly suggests that an early species

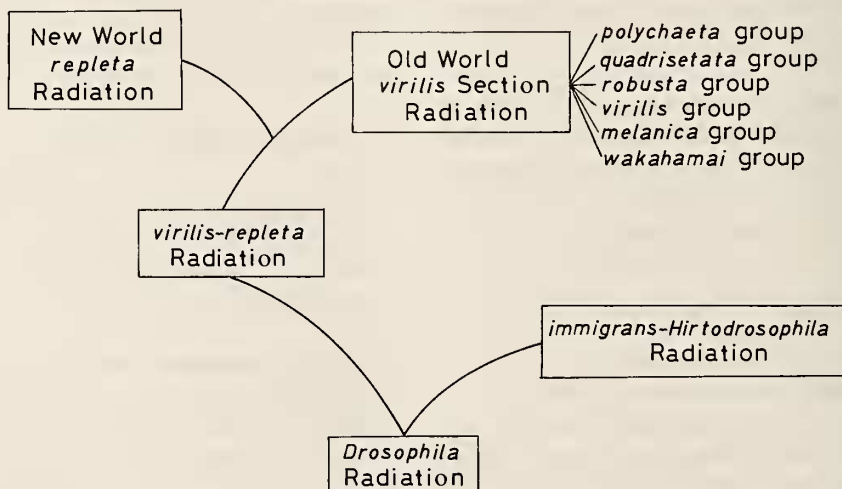


FIG. 27. Phylogenetic relationship of the *virilis* Section in the genus *Drosophila*.

divergence of the *virilis* species-group might have occurred in the mainland of China.

THE ADAPTIVE RADIATION OF THE VIRILIS SECTION

In the family Drosophilidae with about 3,000 species, the genus *Drosophila* is very large and occupies about 54% of the total species number of the family [13]. This genus involves two major phylogenetic lineages, the *virilis-repleta* and the *immigrans-Hirtodrosophila* Radiations (Fig. 27). In the former an early adaptive radiation which produced many species-groups of the *virilis* Section is supposed to have occurred in the Old World tropics, probably in riparian environments [11, 14].

Until recently, however, there has been a lack of information on these drosophilid flies of the Southeast Asia and southern China.

Table 2 shows all members of the *virilis* Section being distributed in Guangdong Province, together with a total species number of the respective groups in the world. It is noticeable that the *quadrisetata* and the *robusta* species-groups are very abundant and that the presumed primitive forms of the species-groups are distributed in

Guangdong Province. From the comparative study of male genitalia, Watabe and Nakata [6] supposed that the *okadai* subgroup might be most primitive in the *robusta* species-group, and two species of this subgroup, *D. gani* and *D. neokadai*, are presently found in southern China [3]. As stated in the *virilis* species-group, *D. virilis* and *D. kanekoi* are considered to be very near to the hypothetical ancestor of the group in the karyotype or the morphological characters. Some of the *polychaeta* and the *quadrisetata* species-group flies have the cercus separated from epanthrium (Table 1), and this genitalial character is common to the *immigrans-Hirtodrosophila* Radiation (Fig. 27). The *quadrisetata* species-group is related to both the *polychaeta* species-group and the *okadai* subgroup of the *robusta* group [1, 4, 6]. With regard to the *melanica* species-group, neither its member nor its related species-group has been found in tropics and subtropics of the Old World. Toda [15] has recently described two new species of this group from Burma, and the newly established *wakahamai* species-group is supposed to have relationships to the *melanica* species-group (Table 1).

The geographic information is of great importance, when considering the evolutionary process of the *virilis* Section. Most of the *polychaeta* group flies are distributed in tropical and subtropical regions of the Old World, and those of the *virilis* and the *melanica* groups in the temperate regions of both the Old and the New Worlds. In Guangdong Province, most of the *polychaeta* group flies inhabit low lands (subtropics), those of the *virilis* and the *robusta* groups in high lands (more than 500 m above sea level) with relatively cool climates, and those of the *quadrisetata* and the *wakahamai* groups in both. A similar distribution pattern of the *virilis* Section groups was found in Yunnan Province [3, 4]. These geographic evidences strongly suggest that first an early adaptive radiation of the *virilis* Section might have occurred in the Old World tropics and produced the *polychaeta* species-group, then this radiation might have yielded the *wakahamai* and the *quadrisetata* groups in subtropics of the East Asia, and finally the *robusta*, the *virilis* and the *melanica* groups might have emerged in its temperate and cold

TABLE 2. The *Drosophila virilis* Section species in Guangdong Province, China (N, new species; C, new to China; G, new to Guangdong Province)

The <i>polychaeta</i> species-group (3/6) ¹⁾
<i>D. polychaeta</i> (G), <i>D. latifshahi</i> , <i>D. daruma</i>
The <i>quadrisetata</i> species-group (5/8)
<i>D. potamophila</i> , <i>D. beppui</i> , <i>D. barutani</i> (G), <i>D. pilosa</i> (N), <i>D. flumenicola</i> (N)
The <i>robusta</i> species-group (6/12)
<i>D. lacertosa</i> , <i>D. cheda</i> (G), <i>D. yunnanensis</i> (G), <i>D. neokadai</i> (G), <i>D. medioconstricta</i> (G), <i>D. gani</i> (G)
The <i>virilis</i> species-group (2/12)
<i>D. virilis</i> (G), <i>D. kanekoi</i> (C)
The <i>wakahamai</i> species-group (3/4)
<i>D. wakahamai</i> , <i>D. velox</i> (N), <i>D. hei</i> (N)
Ungrouped species <i>D. fluvialis</i> Toda et Peng, 1989

¹⁾ n/m : n, number of the species being distributed in Guangdong Province; m, a total number of the species belonging to the respective species-group.

regions.

Little is known on drosophilid faunas of middle and northern China. Further surveys on the Chinese drosophilid fauna and cytological knowledges on chromosomes, proteins, mtDNA and so on are needed to clarify the evolutionary history of the *virilis* Section flies.

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